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Investigation of The Salmon
Fisheries of The Yukon
River 1921



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HUGH M. SMITH, Commissioner

INVESTIGATION OF THE SALMON FISHERIES
OF THE YUKON RIVER

By CHARLES H. GILBERT and HENRY O'MALLEY

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[Extracted from Alaska Fishery and Fur-Seal Industries in 1920. By Ward T. Bower.
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INVESTIGATION OF THE SALMON FISHERIES OF THE YUKON RIVER.

By CHARLES H. GILBERT and HENRY O'MALLEY.

OUTLINE OF PROPOSED INVESTIGATIONS.

An exhaustive investigation of the problems presented by the salmon run of the Yukon River obviously would require practical and scientific inquiry extending over a series of years. During the few summer months no very ambitious program could be attempted. Many of the most important problems must remain untouched. Time would not permit an examination of the tributaries with their spawning beds. No study could be made of spawning habits nor observation of the fate of eggs and fry where these must lie beneath the gravel of the ice-locked streams during the long severe winter and spring. Yet the possible destruction of eggs by freezing may be an important factor in limiting the size of salmon runs in far northern rivers and may, indeed, be responsible for the practical elimination of salmon from the streams that enter the Arctic Ocean. If natural propagation on the Yukon is rendered relatively ineffective because of severe climatic conditions, the operation of hatcheries would here produce proportionately greater results than in more temperate regions. To the extent that natural propagation in any region is wasteful and unproductive do the advantages of artificial propagation appear.

In a single short season it could not be hoped to carry out more than the following program:

1. To inspect the spawning runs as these enter the mouth of the river and to ascertain by microscopic examination of the scales as much as this method can furnish of the life history of the Yukon salmon.

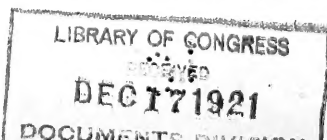
2. To examine the fishery operations carried on by the Carlisle Packing Co., in the Delta of the Yukon, this being the only cannery which packs salmon bound for the spawning beds of the Yukon.

3. To investigate the consumption of fresh and dried salmon by the resident population of the Yukon Valley and to estimate the importance to them of this salmon supply.

4. To draw such conclusions as the facts warrant concerning the magnitude of the Yukon salmon run and its adequacy to support cannery operations in addition to meeting the needs of the local population and providing a sufficient spawning reserve.

ITINERARY.

In carrying out the program above outlined the writers arrived in Skagway on May 12 and crossed White Pass and Lake Lebarge in time to take the first steamer down the Yukon, close behind the running ice of the spring breakup. At Tanana, which was reached May 31, transfer was made to the gasoline launches of the Bureau of



Fisheries, and from June 8 to 13, in company with C. F. Townsend, inspector, Alaska Fisheries Service, the party proceeded by launch to the mouth of the river, arriving June 13 at the entrance to Kwiguk Channel, where was located the floating cannery of the Carlisle Packing Co.

From this date until August 1 attention was given to the fishing grounds located in the Kwikluak mouth of the river and in the off-shore district beyond this mouth, and to the principal channels of the delta which are closed to commercial fishing. From June 25 to July 1 the party proceeded by launch from Kwiguk to Holy Cross and return, to inspect the fishing camps of the lower river during the height of the king-salmon run. From July 5 to 7 a trip was made by launch from Kwiguk to the middle mouth of the Yukon, traversing both the Kwikpak and the Kawanak Passes, returning by way of Old Fort Hamilton, and inspecting en route the run of salmon in these channels. From July 23 to 29 a trip was made by steamer from Kwiguk to St. Michael and return, passing through the Apoon mouth. During the fishing season in the delta careful scrutiny was given daily to the salmon runs, and scale data were secured from extensive series of the different species of salmon which comprise the run.

From August 2 to 20 visits were made to fishing camps along the river from Kwiguk to Rampart, an approximate census secured of the amount of dried salmon, and fishermen interviewed concerning the runs of 1919 and 1920. Having proceeded by steamer from Rampart to Dawson, August 23 to 31, the return was made by launch from Dawson to Tanana, September 1 to 5, visiting on the way the fishing camps of the upper river. This phase of the inquiry terminated at Fairbanks on September 11, after ascending the Tanana River by launch as far as Nenana.

IMPORTANT SPECIES OF SALMON WITH DATA CONCERNING RUNS.

All five of the species of salmon known on the Pacific coast of North America make their appearance at the mouth of the Yukon and ascend that stream for a greater or less distance. Two of these species, however, the humpback salmon and the red or sockeye salmon, are present in such limited numbers as to have no practical significance. The three other species, namely, coho or silver, king, and chum or dog salmon, have substantial runs in the Yukon River, the latter two being of real economic importance.

RED OR SOCKEYE SALMON.

During the entire fishing season of 1920 the Carlisle cannery secured only 5 cases of sockeye salmon, in the neighborhood of 60 fish. As the majority of these were taken on the flats outside the mouth of the river, there might seem warrant to consider them as strays which had wandered from the Kuskokwim, or from some other stream to the southward which possesses a well-marked run of this species. In that case they might not even be entering the river, but playing about for a time in brackish water before finally resorting to their native streams for spawning purposes. In favor

of this theory stands the fact that no breeding ground of the red salmon has yet been reported from any part of the Yukon Basin. The breeding ground of this species could be looked for only in connection with some lake, as the red salmon will not spawn under other than lake conditions. And the males of the species, when on the spawning grounds along the shores of a lake, or in the shallows of the creeks which enter it, are of such brilliant color as invariably to attract attention. It may be, therefore, that no permanent colony of red salmon exists in the Yukon, and that the major portion of the individuals observed off the mouth of the river would not enter and ascend the stream. Occasional individuals do, however, ascend the Yukon, for the writers learned of their infrequent occurrence from observers acquainted with the different species of salmon, and one specimen (a male, decidedly pink in color) was seen at Ruby on August 14. During the much longer fishing season of 1919, 20 cases of red salmon were packed by the cannery.

HUMPRACK SALMON.

The humpbacks appear at the mouth of the river more numerous than the red salmon, but never in sufficient numbers to constitute a run, even of small dimensions. It was noticeable that they were far advanced toward spawning in July, often with liquid milt and partly free eggs. It would be impossible for them to ascend the river far with their spawning period so close at hand. In fact, there were no reports of their occurrence above Andreafski, where a ripe male was observed on August 3.

COHO SALMON.

The least in value of the three principal species is the coho, which runs much less numerous than the other two, and, in addition, is the latest to appear, often not presenting itself in any numbers in the middle and upper reaches of the river until the ice is forming in the fall. This species is little dried on account of its late appearance, but may be fed fresh to the dogs or frozen for later consumption. It seems not to be highly valued for human food.

During the season of 1920 it was entering the mouth of the river in very limited numbers during the last week in July, but nothing approximating a run had at that time developed. The individuals then entering were bright silvery on the sides of the body, without trace of the red coloration which later appears, and the jaws of the male had developed no hook. Later, while inspecting the fishing camps between the mouth of the river and Tanana, from August 2 to 15, everywhere occasional individuals of this species were being taken. At Ruby on August 14 the fish wheels were catching from one to six cohos each day; but at the Ramparts above Tanana on August 20 the species had not yet put in an appearance, nor could anything be learned of its occurrence in the main river above Tanana up to the date of the party's return from Dawson on September 5. The individuals observed below Tanana were running principally along the left (south) limit of the river, and it was reported that their main run was always along the left bank in company with the bright chums ("silver") and such king salmon as run late. To what

extent the early cohos turn into the Tanana it was impossible to determine.

In the lower two or three hundred miles of the river the cohos during the early days of August may maintain the bright silvery coloration with which they enter from salt water, but soon a pinkish tinge appears, which becomes intensified to a bright red before Ruby is reached. At the same time the upper jaw of the male becomes bluntly hooked over the lower jaw, producing the characteristic snub-nosed appearance of this species on the spawning grounds, and the enlarged teeth of the males are soon in evidence. These changes in appearance may have already occurred before entering the river in the case of the latest individuals to enter.

It is most unfortunate that the only name by which the coho salmon is commonly known on the Yukon is "chinook," which is the special name of the king salmon of the Columbia River and is totally inapplicable to the coho. Near the mouth of the Yukon, where the influence of the cannery has been felt, the coho is generally and properly designated as the silver salmon, which is one of the two names by which the species is known in other fishing centers of Alaska. Unfortunately, as will later appear, elsewhere throughout the Yukon the term "silver salmon" is generally but mistakenly applied to an entirely different species. To avoid confusion, therefore, it is suggested that this species be known on the Yukon as the coho, a name by which it is generally known to the trade.

KING SALMON.

The king salmon appears at the river mouth shortly after the ice has run out—in the last week of May or the early days of June. The numbers rapidly increase, the run culminates quickly, and then almost as quickly declines. During the season of 1920 the first king salmon was obtained on June 13, although nets had been set to test the grounds for five days prior to that date. The rapidity with which the run sets in is well shown by the records of the first few days at the cannery. On June 15, 34 king salmon were obtained; on June 16, 175; June 17, 1,639; and on June 18, 5,228, this being the next to the largest take on any day during the season. The largest capture of king salmon in any one day was 6,104 on June 21. In no other day, except the two above mentioned, did the number captured quite reach 4,000. The run may be said to have begun on June 15 and to have culminated within the first week. It continued for some 10 days thereafter at a high level, and then registered unmistakable decline. The average take at the cannery for the best consecutive 16 days of the run was a little more than 3,000 fish per day.

The experience during the previous season, 1919, was very similar as regards the beginning, culmination, and decline of the king salmon run. The fish appeared during the second week in June, ran most abundantly during the following week, continued at a high level for two weeks more, and then rapidly fell off.

The average size of the 1920 king salmon was greater than that of 1919, as is shown by the average number required to make a case in each of the two years. The average number in 1919 was 3.54 to the case, while in 1920 it required but 3.03. The difference was even

greater than is indicated by these figures, for in 1919 comparatively few fish of larger size were taken out for mild curing, while in 1920 there were put up 145 tierces of mild-cured kings, with 800 pounds to the tierce. These were all selected from the larger sizes and would have materially diminished the number required per case if all had been canned.

During the early part of the fishing season the king salmon were silvery in color, without trace of red; the testes are small, hard, and purplish in color; the eggs are always small, not more than half the size when mature. The snout of the males was then so little produced as to give no certain indication of sex. This condition continued during the greater part of June, near the latter end of which the run indicated a decided falling off. But on June 29 a second run appeared of small dimensions, and it was at once apparent that these fish were further along in their development. The jaws of the male were now somewhat prolonged and hooked, and the enlarged teeth had begun to show. They were now reddish in color, and the bellies were so thin that they were little valued for mild-cure purposes. These changes were abrupt and coincided with the sudden increase in the run.

The natural enemies which left traces of their presence on the entering salmon were the white whales, or belugas, and the lamprey eels. Belugas were very much in evidence in the lower river channels during the latter part of the season, the size of their schools increasing as the salmon were running more abundantly. Undoubtedly they were feeding on the salmon, and it is safe to assume that they captured and devoured a very large proportion of those on which they succeeded in closing their jaws. But the number of salmon which appeared on the cannery floor bearing unmistakable tooth marks of the beluga was surprising. The sides were scored lengthwise by widely spaced lines, which usually described a gentle curve, but were occasionally angulated. Evidently these salmon had escaped from the very jaws of their pursuers.

Other marks which attracted universal attention and were usually mistaken for hatchery brands were the scars made by the lamprey eel. This slender eel-shaped animal has an oval sucker-shaped mouth provided with rows of rasping teeth. By means of the sucker mouth it attaches itself to the salmon and may rasp off the skin and even deeper-lying tissues for food. A scar is left which often reproduces with great fidelity the details of the mouth, with its outer fringe of filaments and its inner groups of teeth, which in the scar often give the impression of printed characters.

Such lamprey scars have been occasionally observed in other rivers, but never before in such abundance as on the Yukon. This fact probably stands related to the large lamprey run which is indigenous to this stream. They enter the mouth of the river in the fall after the surface has frozen and run up under the ice, to the under surface of which they often attach themselves when resting. Although the run lasts but few hours at any locality, it is of enormous dimensions and furnishes tons of food to those who dip them up through holes cut in the ice.

Like the salmon, the lampreys enter the river for purposes of propagation, and all die after the eggs are laid. The young soon

after hatching burrow in the mud of the river banks and live like earthworms for an indefinite period of two or more years. After this they pass out to sea when some 6 inches long, and spend the remainder of their life in the ocean. So far as known to the writers, the lamprey scars have been found on salmon exclusively, and on the Yukon never on chums or dog salmon. Some king salmon would have two or even three scars and one was found on a sockeye, but among the thousands of Yukon chums that we inspected there was not one that had been attacked by a lamprey. It is an interesting question whether the Yukon lampreys follow the king salmon of their own river on their feeding grounds and prey on them. It is not known that their attacks are ever dangerous. The salmon observed seemed in no case to have been seriously injured.

That the king salmon ascend the Yukon at a high rate of speed has been accepted generally. An attempt was made to secure reliable records of their first appearance at a large number of localities along the river. Wireless messages were sent to a number of points during the early days of the run before the dates should be forgotten. And, in addition, a number of important records were secured during visits to the fishing camps, some of these giving the catch in detail day by day throughout the season. While it is recognized that the capture of the first salmon of the season at different points along the river may vary within a day or two in relation to the beginning of the run, an examination of the data indicates that this source of error is not serious and that reliable conclusions concerning the rate of travel can be drawn from the table presented. In this table, when two or more records have been obtained from the same locality, the earliest has been selected as giving the first appearance of the king salmon in that portion of the river.

DATE OF CAPTURE OF FIRST KING SALMON AT LOCALITIES ON YUKON RIVER, SEASON OF 1920.

Locality.	Date.	Approximate distance traveled.
		<i>Miles.</i>
South mouth of river.....	June 13
Run begins south mouth.....	June 15
Pilot Station.....	June 20	107
Marshall.....	do.	144
Russian Mission.....	June 21	204
Tucker's fish camp.....	June 23	221
Paimint.....	June 22	259
Holy Cross.....	June 23	279
Halls Rapids, above Anvik.....	June 24	346
Camp 51 miles below Kaltag.....	June 27	440
Kaltag.....	June 28	491
Koyukuk.....	June 29	555
Whisky Creek, above Louden.....	June 27	622
Ruby.....	do.	659
Tanana.....	June 28	804
Fish Creek, above Rampart Rapids.....	July 3	851
Circle.....	July 11	1,227
Charlie Creek.....	July 12	1,317
Eagle.....	July 13	1,402
De Wolf's fish camp.....	July 14	1,478
Dawson.....	do.	1,504

Inspection of the above table shows the slowest rate of travel in the first hundred miles of the river above its mouth. From the entrance of the South Mouth to Pilot Station is approximately 130 miles, but it was five days after the run began in the mouth of the river before the first king salmon appeared at Pilot Station, indicating a rate of about 30 miles per day. Between Pilot Station and Tanana, on the other hand, the rate of travel was slightly more than 80 miles per day. This discrepancy is probably due to the habit of playing back and forth in brackish water, on entering the river mouth, before beginning their serious ascent of the river. It is well known to the fishermen at the mouth of the river that salmon enter the gill nets as numerously from the upstream as from the downstream side. They pass back and forth on the tides, lingering within the fishing district, thus giving the nets many more opportunities to capture them than would be the case if they pursued a direct course on entering the stream.

Three records below Tanana, those of the camp 51 miles below Kaltag, Kaltag itself, and Koyukuk, do not align themselves with the remainder of the series. At the average rate of travel king salmon should have reached Kaltag by the 24th instead of the 28th and Koyukuk by the 25th instead of the 29th. In both of these localities the capture of king salmon was considered of little relative importance, and the records are doubtless defective.

Above Tanana the current of the river increases materially, rapids are encountered, and the intricate channels of the Yukon Flats are to be threaded. It is not surprising to find that the rate of travel in the upper portion of the river becomes reduced. Not only are the difficulties of ascent increased but the potential store of energy in the fish approaches exhaustion. When they enter the mouth of the river they are the richest in oil of any salmon known, but by the time they reach Dawson their flesh is comparatively dry and flavorless, the oil having been expended to supply the energy needed in ascending 1,500 miles against the current and in carrying forward at the same time the sexual changes which precede the act of spawning. The average rate of travel from Tanana to Dawson was slightly less than 45 miles per day, while from Pilot Station to Dawson, involving practically the entire length of the river below Dawson, the average rate was 57 miles per day.

No record of any other river approaches this in completeness nor in the high rate of travel indicated. The unexampled speed with which salmon ascend the Yukon is doubtless associated with the great distances to be traversed before reaching their upper spawning areas, taken in connection with the shortness of the northern summer.

Inasmuch as the investigators were compelled to restrict their attention to the main river, they are unable to designate the principal spawning areas of the king salmon. Limited numbers of kings are reported to turn aside into all the principal tributaries of the lower and middle sections of the river, but it is believed that a relatively large proportion of the run passes beyond the mouth of the Porcupine into the upper portion of the basin.

CHUM OR DOG SALMON.

Although the king salmon is an important source of food to the natives and the white population, it is far surpassed in value by the

chum or dog salmon, which must be considered the principal food product of the Yukon River.

It makes its appearance off the mouth of the river only a few days later than the advent of the king salmon. In 1920 the first chum was obtained June 17, and from the 17th to the 19th, 138 became entangled in the coarse mesh of the king salmon nets set outside the mouth of the river; but none apparently had as yet entered the stream. On June 20, 2 were reported inside the river; June 21, 82; and June 22, 26; but during these three days 856 were taken in the outside nets, indicating clearly that the chums were beginning to school in some abundance outside the river, but that few were entering up to June 22, when the run up the river may be said to have begun. It became greatly accelerated on June 29 and maintained itself with minor fluctuations, until the cannery ceased operations the middle of July. No strictly quantitative results concerning the run of chums could be obtained from the cannery records during this season, as nets with appropriate mesh for capture of chums were not employed until the last week in June. For this reason, the apparent increase in size of run during the latter days of June is certainly overemphasized by the cannery statistics.

The first chums to arrive were further advanced toward sexual maturity than were the king salmon. In the latter the testes and ovaries were small and the snout so little produced in the males that there was no certain external evidence of the sex of the individuals examined. But in the case of the chums, even those earliest to run had the milt white in color and obviously enlarged, and the large eggs were already loosening in the ovary. The jaws of the males were not hooked, but were showing a slight sharpening and elongation, so that sex determination could usually be made from the appearance of the head. All the early chums were bright silvery in color, with abundant oil, and pinkish flesh which turned a deeper red on drying. All of them were in such condition that they would have been classed as "silvers" rather than as "dog salmon" by fishermen of the upper river.

But changes in the appearances of the chums were soon apparent. At first, as in the case of the king salmon, rare individuals, usually males, showed themselves in an advanced stage of development, with brightly colored bars on the sides of the body and long hooked jaws. They stood out conspicuously from their fellows, which were still in the "silver" stage.

But by the last of June, when a great increase suddenly occurred in the take of chum salmon, obvious seasonal changes had appeared in this species, as in the king salmon running at the same period. It was now the rule for the males to exhibit elongated jaws provided with canine teeth, and to show the beginnings of the conspicuous color marks which characterize the spawning males of this species. During the first days of July the run of chums again fell off, accompanied by a further increase in the matured appearance of the fish. As this occurred at the same time in chums and in king salmon, it appeared to the fishermen that the end of the run was in sight.

On July 7 a new run of chums suddenly set in, the great majority of which were of bright silvery appearance and with no further seasonal advancement than had been shown by the fish that ran first in June. Among them were a few stragglers of the previous run, the

males and females equally conspicuous among their silvery companions. On subsequent dates these stragglers became more rare, and when the party left for the upriver on August 2 the few chums that were then running were almost wholly of the pronounced silvery type.

It is unfortunate that confusion should have arisen in the Yukon from a failure to recognize that the dog salmon and the so-called "silvers" represent different phases in the development of one and the same species.

The "dog salmon" are the individuals furthest advanced toward spawning. They exhibit the elongated hooked jaws and enlarged teeth in the male, the bright nuptial coloration, and the impoverished condition of the flesh, which is light in color, largely devoid of oil, and possessing very little substance when dried.

In the "silvers" the eggs and milt are less developed, the jaws of the male are little or not at all hooked, the external coloration is silvery, or with a light flush of red, and the meat is red in color when dried, rich in oil, and valuable both for human food and for dogs.

In general, the "dog salmon" along any stretch of the river consist of those individuals which will turn into some adjacent tributary to spawn, while the "silvers" are on their way to the upper reaches of the river, show relatively little of the sexual changes they will exhibit on their spawning beds, and are still richly provided with the oil which serves as fuel and principal source of nourishment during the long journey still before them.

Many fishermen recognize the difficulty of distinguishing sharply between "dogs" and "silvers" and relieve their embarrassment by recognizing a third class, the "half-breeds." But the term "silver salmon" has acquired a fairly definite and useful significance in the trade. "Dog salmon" are so poor in nourishment that they have indifferent value even for dog feed, and will not be purchased except during times of extraordinary scarcity. The natives will feed them to their dogs, but will not eat them themselves unless king salmon and "silver salmon" are unobtainable.

The use of the term "silver salmon" for bright silvery chums, still rich in substance, is so universal and of such long standing in the interior of Alaska that it seems useless to attempt to supplant it with any other name. Confusion will inevitably result owing to the presence of the totally different species, the coho, which is commonly known in outside waters as the silver salmon. It is proposed, therefore, that the term "silvers," when referring to the Yukon basin, be restricted to the chums known commercially by that name, while the three species of salmon of importance on that stream be known as the king, the chum, and the coho.

It became evident, as we were ascending the river in August, that the "dogs" and the "silvers" were in general keeping apart from each other and were following distinct migration routes. Throughout the entire lower course of the Yukon, from Tanana at least as far as Anvik, the "dogs" predominated on the right (north limit) of the river and the "silvers" on the left limit. This is generally recognized by all the fishermen of that region, who also agree that the "dog salmon" turn into all the creeks and smaller tributaries, while the silvers "dislike the taste of fresh water," as a native fisherman stated the case. It is also recognized that a heavier run of kings and

of cohos is found in company with the "silvers" along the left limit of the river. It appears, therefore, that there is a prevailing use of the left shore by those fish which are bound for the upper reaches of the river. This may have connection with the fact that the majority of the tributaries of the lower river enter on the right bank.

The run of chums is not of uniform character and quality throughout the season. Fishermen recognize a succession of phases in the run, characterized by fish which on the average are recognizably different. In general, it is stated that the run of chums which accompany the king salmon are of relatively small size and poor quality, commonly known as dog salmon. Following these is a run of bright fish of good quality but inferior size, known as "silvers," while the last chums to run, late in August and early in September, are the finest of all, the "silvers" par excellence, a bright rich form distinctly of larger size. This last run of "silvers" ordinarily is of short duration, but is frequently of great intensity, and furnishes the most highly prized fish of the season.

As it was necessary to make a canvass of the entire river before the fishing season had come to a close, the writers were unable to observe the alleged succession of forms of the chum salmon at any locality. Distinct differences in the character and quality of the fish appeared at the various camps visited, but these differences were apparently dependent either on the proximity of the camp to important tributaries into which spawning chum salmon would pass, or, more especially, on the location of the camp with reference to the river itself, whether on the right bank or the left. In general when following up the right (north) bank of the river the quality of the fish became poorer as one approached the mouths of the tributaries. The impression was strong that the fish destined for these tributaries were farther advanced than those with which they were associated on the same side of the river bound for more distant spawning grounds. A further more detailed study of the characteristics of the chums at different times and in different localities and the distribution of the various strains to their respective spawning areas would offer results of importance equally from the biological and from the strictly practical point of view. During the season of 1919 the bright chums, or "silvers," were said to be almost wholly wanting. If these were the fish bound for the more distant spawning beds, then the upper sections of the river must have remained largely unseeded in 1919 and incapable of producing their quota of a subsequent season's supply. In 1920 the run of chums was peculiar, in that it lasted longer than is usual in good years, but was of less intensity, and the August run of "silvers" failed to attain its usual proportions. In subsequent years the late run of "silvers" should be carefully noted. If there is evidence of a progressive decline, steps should be taken to protect this most important part of the run. To accomplish this result information should be obtained concerning the spawning beds which are resorted to by this large and valuable race of chums.

The chums travel up the river at a rate approximately equal to that of the king salmon. In 1920, as has been shown, they were schooling on the tide-flats off the mouth of the river nearly a week before they began to ascend the stream in any numbers on June 22. Adopting the latter date as the beginning of the run, it appears that they

started about a week later than the king salmon. In the section of the river between Loudon and Tanana, they were reported as 8 to 10 days behind the kings, and in the district between Circle and Dawson, the first chum was recorded 11 to 17 days later than the first king. It is evident, therefore, that the chum salmon, also, although apparently far less vigorous than the king, ascend the river at an astonishing rate of speed, maintained without cessation for well over a month, under the necessities imposed on them by the short summer and the rigorous fall climate of the Yukon.

The opinion has already been recorded that the king salmon of the Yukon is the richest in oil of any known king salmon. The same statement, made with even greater emphasis, may be advanced regarding the Yukon chums. This species is noted in other localities for its poor oil and poor color. The canned product is the reverse of attractive in color or in richness, and occupies the lowest rank in the markets of the world. In other river basins the chums do not travel far from the sea, but enter late in the season and seek spawning beds not far inland. But the best of the Yukon chums travel 1,000 to 2,000 miles up a river known for its consistently rapid current. They form a rich table fish in the lower section of the Yukon, where the king salmon, to ordinary palates, contains a superabundance of oil. No more striking evidence of the richness of the king salmon can be found than that presented in the smokehouses of natives in the lower river. Here the drying salmon constantly drip a pure, clear red oil, which is collected in vessels and preserved for winter use. At the village of Ohogamute, above Marshall, we observed some 30 quart bottles filled with red salmon oil, secured this season from drying king salmon.

YUKON DELTA, ITS PRINCIPAL CHANNELS, AND ROUTES MAINLY FOLLOWED BY SALMON.

The Yukon River subdivides numerously within its extensive delta, and sends its waters to the sea through a large number of distinct channels. Many of these are narrow winding canals, which meander in every direction interminably through the flat lands, before they attain the outer edge of the delta. Through all of them, doubtless, some salmon pass, but three of the channels so far transcend the others in size and importance that for practical purposes they may be considered as forming the mouths of the Yukon and the main migration routes of the entering salmon. The channels in question, in order of importance, are Kwikluak Pass, or south mouth, with its important branch, the Kwiguk Pass; Kawanak and Kwipak Passes, which coalesce before entering the sea and form together the middle mouth; and Apoon Pass, or north mouth.

Much the smallest of the three is the Apoon Channel, which traverses the northern sector of the delta, and forms the most direct route for river steamers bound to and from St. Michael. Although exclusively used as a steamer channel, it is poorly adapted for this purpose, being so shallow both within and without the mouth that light-draft boats have quite the habit of going aground there and waiting until a favoring tide shall float them.

Few salmon apparently find their way through Apoon Pass. A few families of natives from Kotlik village had established a fish

camp on the shore just outside the mouth of the river, but the drying frames were scantily supplied with salmon when they were seen in the last week of July. Between the mouth of the pass and old Fort Hamilton no fishing stations were occupied, and the nets operated by the white trader at old Fort Hamilton were having no success. The general belief that Apoon Pass is of little importance as a fishway seemed wholly justified by observations. It has probably no greater importance than have some of the subsidiary channels through the delta.

The lower Kwikpak and the Kawanak Passes, which together constitute the middle mouth, are the least known of the three main divisions of the river. No steamers traverse them and very few natives have their summer fishing camps along their banks. The Kawanak is a stream of large size and fair depth of water and the lower Kwikpak, although choked with sandbars, carries a considerable current.

This middle mouth was visited July 5 to 7, at a time when the Carlisle Packing Co., on request, was testing the run of salmon by setting nets in the lower Kawanak Channel. Two nets were set along the left bank and two others were set offshore along the edge of a bank. This test was made during a slack period in the run in the south mouth, when the king salmon especially were running in greatly reduced numbers and the chums were not coming in full force. During 14 hours' fishing in the Kawanak Channel the four nets took 3 king salmon and 67 chums. In a second test of equal length the following day the showing was even less favorable.

One native fishing camp, which obviously has been occupied for many years, is located on the upper point of the long island which separates the Kawanak and Kwipak channels, immediately below their first confluence near the mouth. Four families were encamped at this place, and reported a favorable catch of king salmon during the preceding two weeks. The run had now slackened, they said, and the chums were just beginning to appear. They had found the season thus far very much better than the preceding year, when they had fished in the same locality. During the season of 1919 they had been unable to secure many more salmon than they had needed for their summer's use. At the time the camp was visited they had caught enough king salmon to fill one rack and two smokehouses, and had made use of two short gill nets of their own make set in an eddy along the bank of the island. The nets were not more than 25 feet long. Later, when a fresh run had entered the south mouth, word was received that the native fishermen in the middle mouth were again making good catches. It seemed, therefore, that the runs in the two mouths were well synchronized, the fluctuations during different seasons and between different days of the same season, following each other closely. This was well shown in a test made in the middle mouth, on request, during the earlier part of the season, when king salmon were running abundantly in the south mouth. This test was made on June 25 and 26, and resulted in a satisfactory catch of king salmon, with very few chums.

In view of the tests here indicated and observations at the fishing camp, it can not be said that the middle mouth lacks importance as a route for salmon. Yet it is considered to be very far indeed behind the south mouth in this respect. It is doubtful whether it equals in

importance the subsidiary channel known as the Kwiguk, which branches off from the Kwikluak Pass, a few miles above its mouth. It may safely be inferred that the native fish camps are located at the most favorable fishing sites. These are occupied year after year and generation after generation by the same families and their descendants. Where native fishing villages are most thickly grouped will be found the largest and most unfailing supply of salmon. With this as a basis, the writers are compelled to conclude that the south mouth serves as the migration route for the greater part of the Yukon run. While no data are available for an estimate, it is not considered beyond the bounds of probability that nine-tenths of the entire run enter by the Kwikluak Pass and its subsidiary channel, the Kwiguk. About 100 families of natives were fishing in this district in 1920, while not to exceed 10 families were seen in the middle mouth below Dogfish Village. In no case did the latter families have equal success with those camped on the Kwikluak Pass.

It is on the Kwiguk Channel, just below its emergence from the Kwikluak, that the floating cannery of the Carlisle Packing Co. has been located during the two seasons of its operation in the delta. Protected from the heavy southerly winds which blow up the main channel during the summer months, this site is within easy distance of the main fishing grounds in the lower part of the Kwikluak Channel and among the offshore shoals and islands. Inasmuch as the Yukon salmon appear largely to travel along the banks, in the eddies, and along the margins of submerged banks, it is believed possible during a favorable fishing season to secure from this location as a base a very considerable proportion of the salmon of the Kwikluak Channel. Fortunately, no commercial fishing for export is permitted in the Kwiguk Channel. Several native families were located on this channel in 1920, and one white trader maintained a wheel. Good catches of king salmon and chums were secured at all of these camps, but it was believed that the run of kings was proportionally not as heavy as in the main channel.

COMMERCIAL FISHERY OPERATIONS IN YUKON DELTA IN 1920.

The fishery operations of the Carlisle Packing Co. in 1920 were conducted principally in the south or Kwikluak mouth of the river and beyond that mouth among the seaward channels which diverge from it. The mouth of the Kwikluak Channel was designated as it was during the previous season by a stake set in the right or northern bank on the projecting point of land at Ingrakaklak (see U. S. C. & G. S. chart 9373) and by a stake set on the left or southern bank of the channel at the entrance to the well-marked lagoon some half mile below Nilak.

A few fishing camps were established by the company as far up the Kwikluak Channel as Dogfish Village, where the main river makes its first grand division into the Kwikluak Channel and a channel which later divides to reach the middle and the Apoon mouths. Above Dogfish Village no fishing camps were established by the company, but they purchased limited numbers of salmon from a few independent fishermen, who operated at points below the mouth of Clear River near Andreafski.

Commercial fishing for export was thus carried on exclusively in the main Yukon, between the mouth of Clear River and Dogfish Village and below Dogfish Village, in the main Kwikluak Channel and its seaward extensions. All subsidiary channels branching off from the Kwikluak were closed to commercial fishing, whether these served as communicating links between larger channels, as in the case of Aproka Pass, or, as in the case of the Kwiguk Channel, secured independent egress to the sea.

But in no case were the salmon which entered through these protected channels given unimpeded access to the upper river. All of them must pass through the 40 or 50 mile stretch of the main river between Dogfish Village and Andreafski, where they were exposed to capture for commercial purposes; and those that enter through the important Kwiguk Channel must in addition run the gauntlet of a further 40 miles of river between the Kwiguk entrance and Dogfish Village. During the past season very little commercial fishing was in fact carried on in the stretch of river above Dogfish Village, but this was of choice and not from necessity, for no restrictions are there imposed by existing regulations.

During the season of 1919, 65 per cent of the king salmon and 61 per cent of the smaller fish—chums, cohos, and sockeyes—were taken beyond the mouth of the river, while in 1920 the proportion was even greater, 69 per cent of the king salmon and 68 per cent of the chums being taken outside.

The fishing grounds in 1920 extended much farther away from the river than in 1919. During a part of the season 12 fishing boats were located between 10 and 20 miles outside Nilak, along the shallow banks bordering the Acharon Channel on the mainland side (U. S. C. & G. S. chart 9373). The outermost stations were for a time the most successful, meeting the Yukon salmon well down the coast toward the mouth of Black River. How much farther in the direction of the Kuskokwim the advancing schools may be encountered in numbers adequate to warrant commercial fishing is as yet undetermined. An expedition which they sent down the coast to Cape Romanof testifies to the interest of the Carlisle Packing Co. in this question.

The fishing methods employed by the company in 1920 did not differ from those in use in 1919. Almost their sole dependence was on gill nets, set in convenient lengths in the eddies and on shallow banks along the main channels. For the most part these were set nets or anchored gill nets, with one end made fast to the shore and the outer end anchored. But during the latter end of the season, when the river was no longer at flood, it became possible to fish on shallow banks, which were not available during the height of the king salmon run. Stake nets were then used in larger numbers and would unquestionably have been availed of more extensively throughout the season had the stage of water permitted.

The gill nets used were of two kinds, the king salmon nets of 8 $\frac{3}{4}$ -inch mesh and the nets for chums and other small salmon of 5 $\frac{3}{4}$ -inch mesh. As the company from the beginning of the season contemplated fishing largely, if not exclusively, for the king salmon, only nets of the larger mesh were issued during the height of the king salmon run, which lasted up to the last days of June. After this

date the smaller mesh nets were also issued, but the number of these on hand was not adequate to supply all the fishermen.

Forty-one boats in all were employed in fishing, 34 of these throughout the season, the remainder for varying periods. Four of them were engaged so short a time and obtained so few fish that they may well be omitted from consideration. To each boat was issued 200 fathoms of king salmon net, and subsequently 200 fathoms of the small mesh salmon net, to the extent that this was obtainable.

In addition to the gill nets, renewed attempts were made in 1920 to use fish wheels. Two of these were constructed by the company, but were no sooner placed for fishing than they were put out of commission by the heavy drift which was running during the early days of the fishing season.

In addition to the above, nine wheels were privately owned and operated within the area open to commercial fishing, and the catch of seven of these was sold in whole or in part to the cannery. A very limited number of salmon were obtained from independent fishermen using nets. The number thus purchased from independent operators using wheels or nets amounted to some 7,400 kings and 27,000 chums, out of a total number handled by the cannery of 58,467 kings and 155,655 chums.

The fishing gear operated by the cannery and by private parties occupied only a narrow fringe along the margins of the channels. No attempt was made to fence or block the main channels in any manner, nor could such an attempt at any time be successful.

The employees at the cannery numbered 254. Of these, 122 were brought in from Seattle, including 40 Orientals and 44 fishermen. Of the 132 Alaskans, 40 were employed as fishermen, while 48 were natives, of which the first crew of 25 ceased work in the middle of the season. It was pleasing to learn from the superintendent that the Alaskan fishermen gave a good account of themselves and would hereafter be preferred by the company.

The pack put up by the cannery in 1920 was far less extensive than in the previous year, as is shown by the following table:

PACK OF SALMON BY YUKON CANNERY IN 1919 AND 1920.

Product.	1919	1920
Canned (cases):		
King salmon.....	28, 582	15, 934
Chums.....	24, 543	12, 819
Cohos.....	3, 181	0
Reds.....	28	5
Mild-cure (tierces).....		145

The comparative lack of success in 1920 was due in part to the unfavorable fishing conditions and in part to voluntary shortening of the fishing season. In 1919 fishing was continued until the close of August, but in 1920 only until the middle of July, as the low market price for chums did not warrant the company in continuing to operate after the run of king salmon was over. The season of 1920 was extremely late on the Yukon, and the king salmon entered with a rush, while yet the river was very high and was carrying down enor-

mous quantities of drift, which clogged the nets and rendered them inefficient. Also, during July the weather was unusually stormy, interfering with the fishing and endangering both fishing gear and the lives of the fishermen exposed on the flats beyond the river's mouth. From the cannery standpoint, the season was a failure, redeemed from actual loss—if such indeed was the case—by the extremely high price quoted this year for king salmon. Yet the cannery pack of 28,758 cases fell short only 1,242 cases of the maximum number of salmon which had been designated by the Secretary of Commerce as safely to be spared for commercial purposes from the Yukon River run.

No fish intended for export from Alaska were salted on the Yukon River in 1920.

SUPPLY OF DRIED SALMON PREPARED ON YUKON RIVER IN 1920.

On the voyage down the Yukon from Lower Lebarge to the delta, following close behind the running ice, May 24 to June 13, few indications could be observed of preparation for the fishing season. Here and there a white fisherman was engaged in constructing his fish wheel in time for the short king salmon run, but the native fish camps were unoccupied. Later it was evident that in comparatively few instances did the natives have wheels in the water in time to obtain any considerable number of king salmon.

On the lower river, below Holy Cross or Paimiut, the natives belong to the InnuIt stock, and fish much less extensively with wheels than do the Indians of the upper river. They employ for the most part short lengths of homemade gill nets, which they set in eddies behind projecting points of the shore. As favorable localities are found almost exclusively along the high right (north) bank of the lower river, the fishing villages are confined to that side.

Above Holy Cross the use of nets becomes less and less an important factor, and wheels are relied on almost exclusively for the capture of salmon. Rarely was the primitive fish trap or basket or the dip net seen in use. The small fish wheels, which seem to have been introduced on the Tanana River in 1904, have been generally adopted on the upper river by whites and natives alike. They cost about \$50 each, in addition to the labor of building them, and are wonderfully effective when skillfully placed.

In the section of the river between Holy Cross and Rampart little dependence is placed by the natives on the king salmon. There is an early short run, and the natives are traditionally dilatory in making preparations. By the time their wheels are in the water the king salmon run is largely over. It is also true that the king salmon are more difficult to preserve, being larger in size and richer in oil. Those that are put up by the natives are kept largely for their own consumption and for this purpose are most highly prized. Taking the river as a whole, a distinct hardship is imposed on whites and natives alike when the king salmon run is below normal.

Unquestionably, however, the chum furnishes by far the larger share of the dried salmon. Along some stretches of the river almost complete dependence is placed on this species, locally known as the dog salmon and the "silvers." The higher grade of chums, known as "silvers," form the staple dog food throughout the Yukon country.

All the traders handle them and may deal in from 5 to 50 tons in a year. But they refuse to purchase dog salmon except as a last resort. The majority of the natives at the close of the fishing season sell a portion of their salmon supply to the trader with whom they deal, frequently leaving themselves without adequate provision for their families and their dogs. Later in the year they are often compelled to repurchase dried salmon at an advanced price, paying for it with the proceeds of their winter trapping. They are, of course, more or less improvident, as in the case of other primitive peoples. Their sale of salmon in the fall is frequently to liquidate their debts to traders who had extended them credit earlier in the season.

In the section of the main river below Rampart, where salmon are still rich in oil and the rainfall during the summer months is usually heavy, resort is had to smoking the salmon in order to preserve them. There is no commoner sight along the Yukon than the cluster of white tents in some picturesque nook among the hills of the right bank, and with them one or more high, barnlike smokehouses, which emit a faint blue vapor. There will be a fish wheel turning in the current along the rocky shore and a number of open-air racks, more or less protected from the weather, on which the salmon are hung for a time until partially dried and ready to be smoked. The picture is, of course, not complete without the native men, women, and children of the summer camp, nor without the invariable row of dogs closely tethered to stakes driven near the water's edge. Here the dogs fatten on the salmon heads and back bones and other refuse. They scratch out shallow holes to lie in alongside their stakes or burrow deep into the adjacent bank, if one be at hand, to escape the implacable swarm of mosquitoes.

Along the Tanana and the upper Yukon is a region of less rainfall, in which also the salmon have relatively dry meat, which is easily preserved. Here smoking is frequently dispensed with and dependence had entirely on air drying. But, by whatever method prepared, the fish of the upper river, of the Innoko, the Koyukuk, and the Tanana, are of inferior grade, and bring a lower price than do fish imported into these districts from the main river. The best product of all is secured from the Rampart Rapids. Here the "silvers" are said to average larger and fatter than in any other section. It is not improbable that inferior strains of dogs and "silvers" have turned into the lower tributaries, leaving at the rapids almost exclusively high-grade fish bound far up the river.

In the coastal district when salmon are running abundantly trenches are often dug in the soil by natives and hundreds of salmon are thrown in without preparation of any kind. They are then covered with earth and nature is permitted to have her unrestricted way with them. When the contents of these trenches are scooped out at some convenient season, perhaps in midwinter, they are said to make acceptable dog feed and to be not wholly shunned by the natives themselves.

The king salmon intended for their own food is often carefully prepared and stored away by natives of the lower river. When sufficiently dried and smoked, the sides are cut into pieces of convenient size and packed solidly in large baskets made for the purpose of woven grass, or willow roots, or frequently of salmon skins which

are neatly fitted together and sewed with sinew. The dog and "silver" salmon are tied in bundles weighing about 60 pounds and stored away in the caches in this shape. King salmon are also put in bundles on the upper river. Mention has been made of the salmon oil obtained as drippings from king salmon. In addition to this product, the eggs are very generally saved, being closely packed in any convenient receptacle, without special attempt at preservation.

During the early part of the king salmon run, from June 25 to July 1, a launch trip was made from Kwiguk to Holy Cross and return for the purpose of inspecting the condition of the salmon racks and obtaining a clue to the extent of the king salmon run along the river. The run had been on in this district about one week, and all the fish racks along the river contained considerable numbers of king salmon. The opinion was general that the season was opening favorably. It is in the delta and along this stretch of river that fishing is conducted largely with short lengths of gill nets set in eddies, and in this district the run of king salmon is a very important factor in providing the winter's supply of food.

In addition to the native camps, there are numerous fishing stations occupied by white men. Many of these men are married to native women, and some of them are found in native camps, dividing the proceeds with the native families. In such cases we observed commonly that the efficiency of the camp was increased. The white men operating on the largest scale were usually holders of winter mail contracts, which necessitated the use of large numbers of dogs. One such mail carrier keeps some 60 dogs and requires annually for their feed from 12 to 14 tons of dried salmon. As these are exclusively dog or "silver" salmon, the number used is between 15,000 and 20,000.

Other white men take dogs to board during the summer and sell all salmon they are able to put up beyond their own needs. Many of the more intelligent natives now count on doing the same. There is a wide and legitimate demand for dried salmon, for use during the winter season when all travel in the interior of Alaska must be by dog team. As it is impossible to carry enough salmon for a long journey, all "dog mushers" depend on the country they pass through. The road houses maintain a supply for this purpose, the dried salmon taking the place of hay and grain in regions where horses are employed, and being equally indispensable.

During the month of August and the first 10 days of September the Yukon was traversed from the delta to Dawson and the Tanana as far upstream as Nenana, traveling in a launch and calling at the fish camps on the way. The number of families was ascertained as accurately as possible, the number of wheels engaged in fishing, and the total amount of dried salmon prepared for the season. In practically every native camp visited, one or more persons had a sufficient understanding of English to enable them to furnish the required information. In the majority of instances the racks, smoke-houses, and caches were inspected, and finally some facility was acquired in verifying by observation the estimates furnished.

By this method the writers are enabled to present an estimate of the dried salmon prepared on the Yukon in 1920, which is based on

more extended data than any heretofore furnished. That it is an understatement of the amount of salmon actually captured and used on the river is obvious from the following considerations:

1. The lower river was canvassed from the 1st to the 15th of August, and there was a later run of "silvers" of limited extent, of which the figures give no account. A message from Holy Cross, dated September 15, indicated a medium run of "silvers" for some three weeks after that point was passed. The still later run of cohos is also not included in the estimates.

2. No clue could be obtained as to the number of salmon eaten fresh during the season, but this must be a considerable item.

3. None of the tributaries of the Yukon were visited, with the exception of the Tanana below Nenana, yet some of these, like the Innoko, the Koyukuk, the Porcupine, and the Stewart, are important streams. The natives in these regions draw on the rivers for their supply of dried salmon, and the white prospectors and miners out on the creeks may obtain their dog feed from the very spawning beds. To what extent spawning beds are invaded for this purpose is not known, but from reports that have been received it would seem probable the figures may reach dimensions of some local importance.

On the Yukon River, from the mouth to Dawson, 97 native fish camps were observed, each of which contained from 1 to 15 families. Three hundred and seventy families were listed, who were engaged in fishing, but the matter was sometimes obscure and the number of families may have been somewhat greater than this. The natives operated 166 wheels, in addition to the short gill nets of the lower river, which were not enumerated. The dried salmon put up by them amounted approximately to 350 tons, or nearly 1 ton to each known family. Many families had less than this amount, but others compensated for the deficiency by harvests of 3, 4, or even 5 tons. The younger generation gives promise of being more provident than the old. Some of them put up large surplus stocks for sale and carry over fish from one season to the next. There is some apparently well-founded complaint that sufficient care is not always given to curing the salmon, so that in rainy seasons like 1920 large stocks may be offered for sale which are rendered almost worthless by mold and decay. One Japanese fisherman operated a wheel on the river and put up 1,200 pounds.

There were 76 white fishing camps, usually with a single white man in a camp, but in a few instances two white men were working in partnership, or a white man in conjunction with natives. There were 91 white men in all, and they prepared approximately 190 tons of dried fish.

On the Tanana River below Fairbanks there were 24 native fishing camps, operating 24 fish wheels and containing approximately 30 tons of salmon. There were also 26 white fishing camps, with 34 wheels and some 52 tons of salmon.

Altogether, on the Yukon and the Tanana, 301 fish wheels were operated in 1920 and resulted in a take of 622 tons. Of this amount 8 per cent were king salmon and 92 per cent were chums. If an allowance of 100 tons is made for the tributaries not visited and for the later runs on the Yukon which were not seen—and this allowance

is almost certainly inadequate—there would be a total provision of dried salmon for the Yukon and its tributaries in 1920 amounting to 722 tons.

The only previous estimate known, based on a partial canvass of the fishing camps, was that prepared by Messrs. H. J. Christoffers and C. F. Townsend, of the Bureau of Fisheries, in 1918 for the purpose of the Yukon hearing of that year. They enumerated 393 fish wheels and a total product of 650 to 700 tons for the Yukon and Tanana Rivers, exclusive of Yukon Territory. Mr. Volney Richmond, manager of the Northern Commercial Co. stores, basing his estimate on conditions throughout the Yukon Valley, intimately known by him for many years, gave 600 tons as a fair annual provision of dried salmon for the region. It is possible that more salmon were dried in 1920 than would represent a fair average for the river, inasmuch as the previous year had been largely a failure, prices for dried salmon had risen to unheard of figures, and all reserve stocks had been exhausted.

Estimating the average dried king salmon at 5 pounds, and the average chum at $1\frac{1}{2}$ pounds, there were about 23,000 kings and 1,000,000 chums put up on the Yukon in 1920 for local use.

COMPARISON OF 1920 WITH 1919.

At all fish camps visited expressions of opinion were invited as to the relative size of the runs in 1920 and in 1919. The evidence given was overwhelmingly in favor of the run of 1919 being considered one of the worst if not the very worst ever known on the Yukon. Natives and whites all were practically a unit in this belief. Those who believed the cannery was not responsible for the shortage were as well satisfied on the subject of the shortage itself as were those who laid the entire responsibility at the door of the cannery. Those who did put up fairly satisfactory supplies of salmon recognized that they were especially favored in their locations, but thought that the river as a whole was relatively bare of fish.

In the lower section of the river more fish would have been prepared if storms had not broken the wheels and interrupted the fishing. Storms also broke wheels and interrupted fishing along this section of the river in 1920, but racks and smokehouses were not empty of fish. The natives about Nulato and Koyukuk would have made better provision for the winter of 1919 had they fished diligently throughout the season instead of potlatching as they did. They would unquestionably have had more fish, but it is doubtful whether they could have secured enough even had they fished consistently with as much diligence as they ever display. It was impossible to doubt, after interviewing several hundred people distributed along the entire length of the Yukon, that the run of 1919 was phenomenally deficient; and, furthermore, that if this condition should become permanent, or should frequently recur, a very serious condition would arise in the interior of Alaska.

No basis is available for a well-founded estimate of the amount of dried salmon put up in 1919, but we believe that 150 or 200 tons would be an outside estimate for the entire river. The price rose to 25, 30, and 35 cents per pound, with no stocks available even at those prices. Men compelled to travel during the winter experienced

the utmost difficulty in securing substitute dog feed. Fresh meat was used, although this is by no means satisfactory, and deplorable numbers of caribou were slaughtered by natives and others for this purpose. Cereals and bacon were made use of, and stores and trading posts soon found their stocks running low. The natives killed, or permitted to die of starvation, half or more than half of their dogs, and many white men were compelled to adopt the same course. Undoubtedly the best dogs were retained and the least valuable were culled out of the teams. But the general opinion entertained by those best acquainted with the natives and their needs was to the effect that the great reduction in the size of their dog teams was disastrous and the dog shortage was sure to hamper them in their efforts to make a living during the coming winter.

There were no reported cases of starvation or of serious suffering among the natives during the winter of 1919 because of the shortage of salmon, although they might well have occurred in outlying districts if help had not been given by white traders and by others. At Tanana rations were issued from the military post at Fort Gibbon, intended to relieve distress among the sick and aged natives of that vicinity. But the winter was in some respects unusually favorable. On the upper river heavy snows drove the caribou to the lowlands near the river, where natives could hunt them without making long sledge journeys with their dog teams into the mountains. Commissioner Mackenzie at Dawson said that had it not been for this fortunate coincidence the Indians in that vicinity would have suffered severely. In the Tanana-Fairbanks district moose were abundant and were easily captured in the deep snows. And farther down the river, in the Nulato-Koyukuk region, the grouse, which had been scarce for a number of years, had begun to come back in their former abundance. Here again had the season not been unusually favorable for securing fresh meat near at hand severe suffering would have been experienced. Such favorable conditions can not be expected to recur should the salmon supply again fail.

To resume, it does not admit of doubt that there was a most serious scarcity of salmon last winter, nor that this was occasioned primarily by an equally serious shortage in the run. By no other theory can so general a failure in the river fishing be explained. The lower and middle sections of the river, the Ramparts and Upper Yukon, the Porcupine, the Tanana, and the Koyukuk, all tell the same story. Dogs were sacrificed in large numbers, which were neither useless nor superfluous, and the natives were saved from serious suffering only by a series of happy coincidences, which could not again be expected.

TO WHAT EXTENT WAS YUKON CANNERY RESPONSIBLE FOR 1919 SHORTAGE?

As the cannery of the Carlisle Packing Co. at the mouth of the Yukon did not operate prior to 1917, and as neither the king, chum, nor coho salmon matures in two-year cycles, it is evident that the cannery could have had no influence on the size of the run which presented itself at the mouth of the river in 1919 and sought access to the spawning beds. The individuals which comprised this run

had all been derived from eggs deposited in the Yukon gravels before ever the cannery was established. There could be no question, therefore of impairment of the run having resulted in 1919 from previous cannery operations.

The only possible effect of the Carlisle cannery up to the present time has been to diminish, by the number of salmon captured, the runs which enter the river and are available to the native and white inhabitants of the valley. In 1919 the company reported the capture of 101,107 king salmon and 357,081 small salmon, largely chums. If these had been captured upriver and dried, the king salmon would then have averaged about 5 pounds each and the chums $1\frac{1}{4}$ to $1\frac{1}{2}$ pounds. Adopting the lower figure, the cannery pack, dried, would have amounted to 252 tons of king salmon and 223 tons of the smaller varieties, or 475 tons altogether. This is held to be more than twice any possible estimate of the amount of dried salmon actually put up during that season on the entire river.

If the 100,000 kings and the 350,000 chums taken by the cannery had been permitted to ascend the river, to what extent, we may ask, would the situation have been helped? It would depend on the size of the run and the proportion which, under the conditions of 1919, would escape capture at the hands of the river fishermen. If the fishing camps along the river were catching 50 per cent of the run, the cannery fish would have added some 235 tons, and the catch would thus have been more than doubled. If they were capturing a third of the run, the cannery fish would have increased their small catch by over 150 tons.

Data for such an estimate are not available. In the muddy waters of the Yukon the schools of salmon are invisible, and no direct estimate can be formed of their numbers. There is abundant evidence, however, that a large majority of the king salmon running in 1919 were captured in nets or encountered nets and escaped from them on the way into the river. White fishermen and natives, practically without exception, including those who felt no hostility to the cannery, agreed that the king salmon averaged smaller in size than ever before and that the relatively few larger individuals were net marked in the majority of cases. The same fishermen, operating in the same localities in 1920, state almost without exception that the king salmon in 1920 averaged large in size, and the number of net-marked fish was so small as to be negligible.

Many opportunities have occurred to observe elsewhere salmon caught in wheels or traps above a district heavily fished with gill nets. The results are always the same. The smaller salmon filter through the nets, which screen out the larger sizes, leaving the average size of the escaping fish always greatly diminished. And many of the fish escape through the web after being temporarily captured, the twine having become so tightly constricted about the body as to leave permanent marks that can not be mistaken. At the rack which was maintained in Wood River above the Nushagak fishing district there was opportunity to examine the fish escaping from gill nets that were capturing from 75 to 90 per cent of the running fish, but never were the escaping sockeyes so extensively net marked as the Yukon king salmon are credibly reported to have been in 1919.

Not all the screening out of the larger sizes and the net marking was due to the operations of the cannery. Natives in the lower river also fish for king salmon with nets, but the extent of their operations is so very small compared with that of the cannery in 1919 that the effect was negligible. Fishermen interviewed stated that they had in previous years seen a few net-marked fish prior to the opening of the cannery, but never anything to compare with the condition observed in 1919. The prevalence of small-sized king salmon in 1919, taken in connection with the extent of the net marking, may justly be considered a measure of the closeness with which these salmon were fished in 1919.

What was true of the king salmon was true also, it is believed, of the run of chums. Fishing for these was prosecuted during the months of June, July, and August. Conditions at the mouth of the river were comparatively favorable for a maximum catch throughout the season. As the salmon move back and forth with the tides, passing up and down the banks where nets are staked, and loitering in the eddies where other nets are anchored, the cannery gear has repeated chances to ensnare them. One of the principal deficiencies in the 1919 run in the upper river was the almost total failure of the "silvers." These, it will be recalled, are the bright chums of high quality which run after the king salmon have passed. It was to these that the cannery devoted its attention after the king salmon nets had been retired. In 1919 the king salmon run had materially declined by July 5, and it was after this date that 272,717 out of the total 357,081 small salmon (principally chums) were taken. It is considered certain that the operations of the cannery in 1919 very materially added to the scarcity of fish on the river. Had the fish captured by the cannery been free to enter the river, the run would still have been below the normal size, but the distress and inconvenience occasioned to the interior of Alaska by the salmon shortage would have been largely mitigated.

EFFECT OF CANNERY IN 1920.

The run of 1920 has been universally approved by fishermen as the most favorable since 1916. Salmon were abundant, of good average size, and of excellent quality. Some fishermen acclaimed it the largest run they had ever seen on the river, but the majority called it a fair average run of the better class of years. Certain it was there was no necessary lack of dried salmon anywhere on the main river as far upstream as Dawson. Some complaint was heard of insufficient fish supply on the Yukon Flats in the vicinity of Fort Yukon, and it was noted in certain native villages between Circle and Forty-Mile that scant provision seemed to have been made for the winter. But it was not evident that there was any lack of salmon. All white fishermen and some natives in these districts made good catches and reported the fish abundant. At Dawson, where serious complaints were heard the previous year, sufficient supplies were secured in 1920. Such slackness as apparently existed in certain native camps may find its explanation perhaps partly in the effects of the "flu," which ravaged some of these communities in the spring of the year, partly in superabundance of money, owing to high prices received for muskrat pelts, and partly, in some com-

munities, to a general shiftlessness, which habitually leads to privation and suffering in the winter.

A similar condition was observed in certain fish camps on the lower Tanana, in which natives seemed obviously less intelligent and less efficient than in the great majority of camps on the main river. In a few of these was heard the complaint that there were no fish, but it is believed that their scant supply was due to other causes. It is of course true that any scarcity will first declare itself on the upper river and among the tributaries, after the salmon, which run in a single channel in the main river, have distributed themselves over a far wider area. It is regretted that reliable reports could not be obtained from the Innoko, the Koyukuk, and the Porcupine.

In comparing the effects of the cannery in 1920 with those in 1919 conditions are met in the two years that were the very reverse of one another.

In 1919 the total run of salmon was far below normal, the conditions for fishing at the mouth of the river were favorable, the cannery catch was very large, and considered in relation to the number of salmon running it was far larger.

In 1920 there was at least a fair average run of the better class, and not improbably it was one of the best runs that can be expected in the Yukon; but the cannery was unsuccessful, owing to adverse fishing conditions. It obtained little more than half as many kings as in 1919 and less than half as many chums. Had the 58,000 kings and 155,000 chums been permitted to enter the river more salmon undoubtedly would have reached the spawning grounds, but the amount of dried salmon would not have been greatly increased. In the first place the number released would bear a small ratio to the total number running in so good a year; and, furthermore, along that section of the river which put up by far the larger amount of dried salmon, wheels, if operated more than a few hours each day during the height of the run, caught more fish than could be cleaned and prepared for drying. It does not then appear that with a large run of salmon and a relatively small cannery pack the latter has any recognizable effect in lessening the dried salmon supply of the Yukon. We are not prepared, however, to venture the assertion that such would have been the case had the cannery pack in 1920 reached as large proportions as it attained in 1919. But even had the cannery put up the full 60,000 cases in 1920, for which it made preparations, it would not have reproduced the severe conditions which existed on the river in 1919. These, as has been shown, were the result of a phenomenally poor season, made much worse by a large cannery pack.

GENERAL DISCUSSION AND RECOMMENDATIONS.

The dependence of the native and white population on the salmon supply of the Yukon admits of no question in the minds of any who have acquaintance with the conditions of life in the great interior of Alaska. The natives have other sources of food, but the salmon form their main provision for the winter—their insurance against starvation when other sources of food fail them, as they not infrequently do. No one who inquires into the matter can doubt that if

the supply of Yukon salmon should become seriously curtailed widespread suffering and death would in many seasons be visited on the natives.

The question of furnishing food for the whites is less urgent, but is not without importance. It was brought to our attention that with the price of all articles of food rapidly rising, while wages in the interior of Alaska have shown practically no increase during recent years, the presence of a cheap source of food is of value.

But one of the most important phases of the salmon question, which concerns whites and natives alike, is in relation to the dog. The whole scheme of things in the sparsely populated Yukon wilderness is predicated on the dog, and the use of the dog necessitates dried salmon. The winter is the only time for travel except along the waterways of Alaska, and winter travel is impossible without the dog team. Dogs are equally indispensable as draft animals and pack animals. Transportation of the winter mails over thousands of miles of the interior of Alaska must be accomplished by dog team. Men of the Army and the Signal Corps, like all other people in Alaska, are dependent on the dog whenever business makes it necessary for them to undertake winter travel. Fort Gibbon alone needs 40 tons of dried salmon each year to feed the dogs that they find indispensable in their work. Prospectors need them to carry their supplies into the hills. Wood choppers require them to haul in the wood. Indians must have them on their long hunting and trapping expeditions, and without them can neither secure meat for their families nor furs to exchange for the other necessities of life.

The dog is as essential in Alaska as is the horse in other regions, and the only acceptable dog feed is dried salmon. Various substitutes have been tried out when salmon could not be procured. They were used extensively by the "dog-mushers" of 1919, when dried salmon often could not be had at any price. Fresh meat was used, and enormous numbers of caribou and moose were slaughtered for this purpose. But it is impossible to carry sufficient meat for many days, and the supply is precarious. Furthermore, the dogs do not thrive and work well on this diet. A diet of cereals and fat in some form was extensively used. Stocks of rice, flour, corn meal, and bacon were heavily drawn on. Dogs traveled well on a ration of corn meal and bacon, but the expense was almost prohibitive, and there was the labor of cooking up each night in camp a meal for the dogs after the exhausting travel of the day with the temperature perhaps 50° below zero and a weary famished team waiting to be fed. Dried salmon forms a light condensed food which contains all the elements needed to keep a hard-working team in excellent condition, and it is always ready to be fed without preparation. There is no acceptable substitute, and there is not in Alaska any divergence of opinion on this subject. No single need in the interior of Alaska is more generally or more urgently felt than dried salmon for its various uses.

It is clear, then, that the Yukon and the Kuskokwim offer salmon problems which are not pressing on any other Alaskan rivers with the exception of the Copper River. These streams drain the far northern interior districts of Alaska with long severe winters and the briefest of summers. The inhabitants are few in number and are distributed widely over a wilderness which is largely without

population. Their lives are subject to the most severe conditions of existence. Largely they are dependent on the resources of the country. To deprive these people of one of their most valued and most important resources would seem under such circumstances peculiarly indefensible. The principle should be adopted with regard to the interior rivers of Alaska that no commercial interests should be permitted to exploit them until it should be demonstrated that a portion of their salmon run could be spared without detriment to the run itself and without encroaching on the supply needed by the populations that inhabit the valleys of these rivers. And if there is any question whether the salmon run in a given stream is adequate to supply the demands of commercial operations as well as the needs of the inhabitants, the doubt should at once be resolved in favor of the people. The subject should not be one for experiment. Canneries should not be permitted to establish themselves on these streams while we calmly await the result. They may create havoc before the evidence thereof is clearly shown, and in the meantime they will have secured those highly prized "vested rights" which make their position difficult of attack.

A floating cannery operated by the Carlisle Packing Co. is already established at the mouth of the Yukon, and it becomes appropriate to inquire whether the continued operation of this cannery is compatible with the best interests of the Yukon Valley. It is evident that if the fish required by this company can without question be safely spared, the cannery should be welcomed, for it provides much needed freight for a transportation company that supplies the Yukon and it offers much needed employment for a limited number of natives and others during a brief period of the summer. But if the operation of the cannery should threaten encroachment on the supply of salmon needed in the interior it should be compelled to close, as no advantage to its few employees could possibly compensate for widespread inconvenience, distress, and suffering.

As a result of the Yukon hearing, given in Seattle, Wash., November 20, 1918, the Secretary of Commerce promulgated an order that limited the pack of canned salmon to 30,000 cases in any year from the Yukon River, embracing all waters of its delta to and including the area 500 yards outside each mouth or slough of the delta at mean high tide. Beyond this area of 500 yards outside the mouth or mouths of the river the Secretary of Commerce exercises no jurisdiction, the Congress having failed to confer it upon him. He is therefore helpless to extend protection to channels between shoals and islands off the mouth of any river, although such channels may be regular migration routes of the salmon bound for that river and as much open to attack as any part of the river channels.

Realizing this deficiency of the laws, the Carlisle Packing Co. in 1919 put up approximately the maximum pack inside the river, and then proceeded nearly to double this with salmon equally bound for the Yukon which they captured outside the mouth of the river. In doing this they were wholly within their legal rights, but they evinced thereby an indifference to the obvious purport of the order, which was to provide for a strictly limited pack of Yukon fish. In making this increased pack they happened on a year when the run was poor and the fishing conditions were excellent. They were

enabled, therefore, to give a demonstration of the results of such operations when these two conditions appear in conjunction. The disastrous year of 1919 resulted.

As to the future, there is no assurance of better protection than in 1919. From our inquiries it appears that the Yukon runs of salmon are by no means uniform in size. Good years and poor years alternate, and occasional very poor years have always appeared. Meanwhile the Carlisle company continues to operate without check beyond the mouth of the river. Should they consider the prospect of success warranted the expenditure, there is nothing to prevent their increasing the number of fishermen and preparing for a pack of 100,000 instead of 60,000 cases. Or one or more other companies may join in the business of catching Yukon salmon off the mouth of the river if they consider the venture a promising one. The Yukon run is wholly without adequate protection as long as the approaches to the river are open to unrestricted fishing and are outside the jurisdiction of the Secretary of Commerce.

Finally, it is the judgment of the writers that the Yukon River salmon run is not to be relied on annually to produce a surplus for export in addition to the supply needed for local requirements and the further quantity essential for propagation. During good years a surplus might be spared sufficient to produce a limited pack, but during poor years the operation of a cannery will have the effect of making a bad situation very decidedly worse.

It is recommended, therefore, that all commercial fishing for export be prohibited in the Yukon River and its tributaries, including the waters of the delta and an area 500 yards outside the mouth of each channel or slough of the delta.

Furthermore, it is recommended that immediate steps be taken to have brought within the jurisdiction of the Secretary of Commerce all those channels between the shoals and islands which form the approaches to the Yukon in order that commercial fishing in said channels for export may be effectively limited or entirely prohibited.



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